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Coal Combustion Waste Impoundment

Dam Assessment Report

Havana Power Plant
Dynegy Midwest Generation, Inc.
Havana, Illinois

Project # 0-381

Assessment of Dam Safety
Coal Combustion Surface Impoundments
for the REAC Program

Prepared for:

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INTRODUCTION

The release of over 5 million cubic yards of coal ash from the Tennessee Valley Authority's Kingston, Tennessee, facility in December 2008 serves as an important reminder of the need for our continued diligence on disposal units where coal combustion wastes are managed. The coal ash from the facility flooded more than 300 acres of land, damaging homes and property. It is critical that we all work to the best of our abilities to prevent a similar catastrophic failure and resultant environmental damage. One of the first steps in this effort is to assess the stability of the impoundments and similar units that contain coal combustion residuals and by-products to determine if and where corrective measures may be needed and then to carry out those measures as expeditiously as possible.

This report for the Havana Power Plant facility assesses the stability of the following management units. This evaluation is based on a site assessment conducted on (add date) by (add name of contractor and subcontractor for USEPA.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking.

In February 2009, the EPA sent letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units. The EPA used the information received from the utilities to determine preliminarily which management units had or potentially could have High Hazard Potential ranking.

The purpose of this report is to evaluate the condition and potential of waste release from the selected High Hazard Potential management units. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal

agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

EPA sent two engineers from Dewberry, one of whom was a professional engineer (PE), for a one-day site visit. The two-person team met with the owner of the management unit to discuss the engineering characteristics of the unit as part of the site visit. During the site visit, the team collected additional information about the management unit to be used in determining the hazard potential classification of the management unit(s).

Factors considered in determining the hazard potential classification of the management units(s) included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s). The team considered criteria in evaluating dams under the National Inventory of Dams, in making these determinations.

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion waste management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

The below conclusions were reached as a result of an extensive visual investigation performed on Wednesday, May 27, 2009, as well as a review of existing documentation acquired from various sources including information provided by Dynegy Midwest Generation, Inc (Dynegy), the current owner and operator of the Havana Power Plant.

These conclusions apply to the East Ash Pond System. The North Ash Pond System is an incision and not an embankment. There is an additional closed South Ash Pond System.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s). The embankments viewed in the field appeared to be well designed, constructed and well-maintained. There were no visible signs of seepage or sloughing, nor were there any large diameter trees on the embankment.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s). The embankments appeared to be safe from overtopping and resulting failure. The management units do not drain any appreciable areas other than the surface area of the ponds. Overflow provisions exist in the event the water level rises to near top of embankment levels.

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation. The supporting technical documents appear to be adequate. The original design calculations and drawings are included as Document 9 in Appendix A.

1.1.4 Conclusions Regarding the Description of the Management Unit(s). The description of the management units provided by Dynegy was an accurate representation of what was observed in the field.

1.1.5 Conclusions Regarding the Field Observations. Dewberry staff was provided access to all areas in the vicinity of the management units required to conduct a thorough field observation. The conclusions provided in this section reflect the engineering team's field observations. The team observed no conditions requiring immediate remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation. The current maintenance practices appear to be adequate for the East Ash Pond System.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program. The surveillance and inspection procedures outlined in the Operations and Maintenance Plan appear to be adequate. There is currently no instrumentation monitoring plan for embankment performance of the management units themselves, however, there is a monitoring plan for groundwater quality.

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1.1.8 Conclusions Regarding Suitability for Continued Safe and Reliable Operation. The field observations and review of documents lead the Dewberry team to conclude that the condition of the East Ash Pond System appears to be adequate for continued safe and reliable operation. Furthermore, this unit can be classified as SATISFACTORY based upon the guidance issued in the Scope of Work, in which SATISFACTORY is defined as, "No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria. Minor maintenance items may be required."

1.2 RECOMMENDATIONS

Based on the above conclusions as well as the sum of information found within this report, the recommendations presented below are proposed.

1.2.1 Recommendations Regarding the Structural Stability. No recommendations appear warranted at this time.

1.2.2 Recommendations Regarding the Hydrologic/Hydraulic Safety. No recommendations appear warranted at this time.

1.2.3 Recommendations Regarding the Supporting Technical Documentation. No recommendations appear warranted at this time.

1.2.4 Recommendations Regarding the Description of the Management Unit(s). No recommendations appear warranted at this time.

1.2.5 Recommendations Regarding the Field Observations. No recommendations appear warranted at this time.

1.2.6 Recommendations Regarding the Maintenance and Methods of Operation. No recommendations appear warranted at this time.

1.2.7 Recommendations Regarding the Surveillance and Monitoring Program. No recommendations appear warranted at this time.

1.2.8 Recommendations Regarding Continued Safe and Reliable Operation. No recommendations appear warranted at this time.

1.3 ANSWERS TO QUESTIONS FROM EPA

On 7/23/09, EPA requested response to the following questions, in response to the draft report of findings of the Kingston embankment failure:

1.3.1 Concerning the embankment foundation, was the embankment construction built over wet ash, slag, or other unsuitable materials? If there is no information just note that.

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Based on our review of design drawings, it appears the embankment was constructed over a suitable foundation. However, the information furnished by Dynegy does not fully support this.

1.3.2 Did the dam assessor meet with, or have documentation from, the design Engineer-of-Record concerning the foundation preparation?

Yes; the Engineer-of-Record, David Gaskins, was present during the site visit and the meetings prior to the site visit. Questions about the foundation preparation were raised and satisfactorily answered.

1.3.3 From the site visit or from photographic documentation, was there evidence of prior releases, failures, or patchwork on the dikes?

There was no evidence of prior releases or failures that were noted during the site visit. Photographs were taken of nearly all portions of all embankments (see Appendix B).

1.4 PARTICIPANTS AND ACKNOWLEDGEMENT

1.4.1 List of Participants

(See Appendix D for more information on Site meeting attendees)

Cleighton Smith, Dewberry
Lauren Ohotzke, Dewberry
Rick Diericx, Dynegy
David Gaskins, Engineering Design Services
Jim Watson, Dynegy
Phil Morris, Dynegy
Joe Kimlinger, Dynegy
Chris Liebman, IEPA
Ted Dragovich, IEPA
Doug Van Nattan, IEPA
Ken Berry, URS

1.4.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on May 27, 2009.

Cleighton Smith, PE (IL # 062.040606)

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Lauren Ohotzke, Civil Engineer

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2.0 DESCRIPTION OF THE COAL COMBUSTION WASTE MANAGEMENT UNIT(S)

2.1 LOCATION

The Havana Power Plant is located in the town of Havana, in central Illinois on the east bank of the Illinois River, approximately 38 miles southwest of Peoria. There are a total of three Coal Combustion Waste management units at the Havana Power Plant: the four-cell East Ash Pond System, the North Ash Pond System, and the closed South Ash Pond System (see Figure 1).

As shown on Figure 2, the site vicinity map, the four-cell East Ash Pond System is located just east of SR 78 (Oak Road). Cell 1 within the EAPS is the southernmost cell. Cell 4 is directly north of Cell 1; Cell 2 is directly north of Cell 4; Cell 3 is directly east of Cells 2 and 4 but extends farther north than Cell 2(see Figure 1).

The two-cell North Ash Pond System is located along the eastern bank of the Illinois River, just west of SR 78 (Oak Road) and just south of the power generating facilities.

The South Ash Pond System is just south of the North Ash Pond System.

2.2 SIZE AND HAZARD CLASSIFICATION

The size and hazard classification is reported only for the East Ash Pond System at the Havana Power Plant. The North Ash Pond System is an incision and not an embankment and therefore not subject to size and hazard classification. The South Ash Pond System is officially closed (see closure letter - Appendix A, Document 8).

The East Ash Pond System has a total surface area of 90 acres. The maximum height of each individual cell is as follows: Cell 1 - 25 ft, Cell 2-40 ft, Cell 3-38 ft, Cell 4- 40 ft.

A hazard classification of High, as rated in the National Inventory of Dams (NID) database has been assigned to the East Ash Pond System. Similar in rating scale is the designation of a Class I rating given to the cells within the East Ash Pond System by the Illinois Department of Natural Resources (IDNR). Furthermore, the IDNR has classified Cell 3 of the EAPS as an "intermediate-size" dam, and Cells 1, 2, and 4 of the EAPS as "small-size" dams under IDNR permit No. DS2002185.

2.3 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The East Ash Pond System is designed to permanently contain the following:

- Fly ash
- Bottom ash
- Boiler slag
- Unit 6 bottom ash sluice water

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Unit 6 dry fly ash handling area drainage
Dredged material
Units 1-6 demineralizer regenerate wastes
Unit 6 condensate polisher wastes

The East Ash Pond System currently processes Coal Combustion Waste in Cells 1, 2, 3, and 4. The estimated design volume/capacity of the entire East Ash Pond System as a whole is approximately 2,625 ac-ft. Accordingly, each cell's capacity and contents is described below.

Cell 1 has a maximum design volume/capacity of 520 ac-ft and is reported by Dynegy to be currently operating at a capacity of 506 ac-ft. Cell 1 currently contains the materials listed above that will permanently exist within the East Ash Pond System.

Cell 2 has a maximum capacity of 620 ac-ft and is reported by Dynegy to be currently operating at a capacity of 565 ac-ft. Cell 2 currently contains the materials listed above that will permanently exist within the East Ash Pond System.

Cell 3 has a maximum capacity of 1,410 ac-ft and is reported by Dynegy to be currently operating at a capacity of 310 ac-ft. Cell 3 currently contains the materials specified above that will permanently exist within the East Ash Pond System.

Cell 4 has a maximum capacity of 75 ac-ft and is reported by Dynegy to be currently operating at a capacity of 7 ac-ft. Cell 4 currently contains the materials specified above that will permanently exist within the East Ash Pond System.

Dynegy has estimated the volume of the materials currently stored in the North Ash Pond System is 5 ac-ft. The maximum estimated design storage volume, or the capacity, of this unit is 25 ac-ft. As specified by Dynegy, this system has been designed to permanently contain the following:

Fly ash
Bottom ash
Boiler slag
Units 1-6 ash hopper overflow
Units 1-6 boiler blowdown
Units 1-6 demineralizer regenerate wastes
Units 6 condensate polisher wastes
Units 1-6 floor and sump drainage
Units 1-5 miscellaneous heat exchangers
1-5 ash handling equipment drainage
Unit 6 coal pile runoff
Unit 6 transformer drains
Unit 6 roof drainage
Yard area runoff

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Water softener backwash
Service water strainer backwash
Units 1-6 nonchemical metal cleaning waste
Unit 6 cooling tower blowdown
Winter low point drain line
Accumulated coal barge stormwater
Reverse osmosis unit concentrate
Reverse osmosis unit maintenance waste
Activated carbon treatment system effluent
Activated carbon treatment system effluent
Groundwater remediation project discharge
Units 1-6 water sampling system drains

However, Dynegy noted that the North Ash Pond System is currently only receiving coal pile runoff under normal operations. If the East Ash Pond System cannot receive Coal Combustion Waste, it would be sent to the North Ash Pond System as a back-up.

2.4 PRINCIPAL PROJECT STRUCTURES

2.4.1 Earth Embankment Dam. Based on Dynegy design files, the East Ash Pond System is comprised of earth embankments with downstream side slopes of 3:1 (horizontal: vertical) and upstream side slopes of 3:1. There is an impervious area comprising of a 1 foot clay blanket under a geo-membrane liner on the upstream side. The geo-membrane liner covers the entire pond. The North Ash Pond System is an incision – not an embankment. Dynegy reports that little is known about its design.

2.4.2 Outlet Structures. The outlet structure of the East Ash Pond System is an overflow type circular spillway that discharges into a 36-inch diameter concrete pipe that drains to the Illinois River. An emergency overflow structure exists (i.e., a concrete spillway) on the downstream face of Cell 4.

2.5 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

The inundation map prepared by Dynegy for their Emergency Action Plan (see Appendix A: Document 1.1 and Document 9, pages 2 and 3) indicates that the failure floodwave would dissipate before five miles down gradient. Nonetheless there are homes located immediately down gradient of the Cell 3 embankment as well as an abandoned factory. There is a school within two miles.

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3.0 SUMMARY OF RELEVANT REPORTS, PERMITS AND INCIDENTS

3.1 SUMMARY OF REPORTS ON THE SAFETY OF THE MANAGEMENT UNIT(S)

Dynegy recently contracted URS Corporation to perform an inspection of the embankments at the East Ash Pond System in 2009, however the report has not yet been completed. Prior inspections have been performed annually from approximately 1990 through 2008. We have not requested any of these reports from Dynegy to date.

3.2 SUMMARY OF LOCAL, STATE AND FEDERAL ENVIRONMENTAL PERMITS

The State of Illinois Department of Natural Resources Dam Safety Office has regulatory oversight over the embankments comprising the East Ash Pond System (permit number is DS2002185).

3.3 SUMMARY OF SPILL/RELEASE INCIDENTS (IF ANY)

N/A

As stated by Dynegy, to the best of their knowledge, the East Ash Pond System has not had any spills or unpermitted releases of coal combustion residues or byproducts to surface water or land.

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4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

The East Ash Pond System was designed by and constructed in stages from 1990 to 2003 under the supervision of a registered Professional Engineer, who was employed by the owner/operator of the Havana Power Plant at that time.

According to Dynegy, there was no record of whether or not the North Ash Pond System was designed by, or under the supervision of a registered Professional Engineer.

4.1.2 Significant Changes/Modifications in Design since Original Construction

There have not been any significant changes/modifications in design since original construction at the Havana Power Plant.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

There have not been any significant repairs/rehabilitations since original construction at the Havana Power Plant.

4.2 SUMMARY OF OPERATIONAL HISTORY

4.2.1 Original Operational Procedures

The four cells of the East Ash Pond System were commissioned (started receiving ash) as follows: Cell 1 in 1990, Cells 2 and 4 in 1997, Cell 3 in 2003.

The North Ash Pond System was commissioned (started receiving ash) in 1947 and, according to Dynegy, has not been expanded since.

4.2.2 Significant Changes in Operational Procedures since Original Startup

None reported by Dynegy.

4.2.3 Current Operational Procedures

The current operational procedures at the Havana Power Plant, as reported by Dynegy, are as follows:

- .....Fly ash is transported dry to East Ash Pond System Cell 3, where it is wetted and discharged into Cell 3;
- .....Boiler ash is wetted at the plant and pumped to East Ash Pond System Cell 3.
- .....Coal pile runoff is directed to the North Ash Pond System. Decant water is then pumped to East Ash Pond System Cell 2. Dynegy reports that the North Ash Pond System is permitted to receive Coal Combustion Waste, but under current operation practices, this would only occur if discharge could not be made into the East Ash Pond System.

4.2.4 Other Notable Events since Original Startup

There are no other notable events (reported by Dynegy) since original startup.

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5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Both the East Ash Pond System and the North Ash Pond System were visually observed on Wednesday, May 27, 2009. A series of photographs taken during this observation can be found in Appendix B of this report. In addition, a field checklist is included as Appendix C.

Based upon the field observations, the following findings are reported:

- .....The embankments at the East Ash Pond System, designed by a professional engineer, appear to be well constructed and structurally sound. There is regulatory oversight under the State of Illinois Dam Safety Program.
- .....The North Ash Pond System was constructed as an incision and does not use embankments as part of their design.
- .....A third ash pond system exists (the South Ash Pond System), but has been officially closed (see Appendix A, Document 8 for official closure letter).

5.2 EARTH EMBANKMENT DAM

5.2.1 Crest – appears to be structurally sound.

5.2.2 Upstream Slope – appears to be structurally sound.

5.2.3 Downstream Slope and Toe – appears to be structurally sound; although a few ponding areas at toe were noted but deemed to be from recent rains.

5.2.4 Abutments and Groin Areas – not applicable.

5.3 OUTLET STRUCTURES

5.3.1 Overflow Structure – appears to be structurally sound.

5.3.2 Outlet Conduit – not visible.

5.2.3 Emergency Spillway (If Present) – appears to be structurally sound.

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6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION (Provided by Dynegy, see Appendix A, Document 9)

6.1.1 Floods of Record – Not recorded by Dynegy.

6.1.2 Inflow Design Flood – One-half of the Probable Maximum Flood consistent with IDNR Dam Safety criteria. As there is no contributing areas to these impoundments, this is essentially the precipitation on the pond surface plus the maximum plant outflow.

6.1.3 Spillway Rating – Calculations for design of primary spillway and emergency overflow spillway are contained in Appendix A, Document 9 (1).

6.1.4 Downstream Flood Analysis – Dynegy has performed a dam-break analysis and prepared an inundation map (see Appendix A, Document 9 (1), pages 2 and 3).

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION – Appears to be adequate.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY – Appears to be adequate.

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7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed – Provided by Dynegy (Appendix A, Document 9 (7))

7.1.2 Design Properties and Parameters of Materials – Provided by Dynegy (Appendix A, Document 9 (7))

7.1.3 Uplift and/or Phreatic Surface Assumptions – apparently not considered in design, due to liner on upstream side.

7.1.4 Factors of Safety and Base Stresses – Provided by Dynegy (Appendix A, Document 9 (7)), greater than 1.5 for all cases considered. This is consistent with accepted practice for design of this type of embankment.

7.1.5 Liquefaction Potential – apparently not considered in design, due to seismic conditions and foundation soil conditions.

7.1.6 Critical Geological Conditions – Provided by Dynegy (Appendix A, Document 9 (7)). Site is in seismic zone 1, factor of safety is greater than 1.0 for all cases considered. This is consistent with accepted practice for design of this type of embankment.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION – Appears to be adequate, despite no evidence of uplift/phreatic considerations or liquefaction potential.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

The embankments at the East Ash Pond System are structurally stable, based on:

- ……review of design calculations, including factors of safety for embankment stability for a variety of load cases, as well as a review of other design calculations, all of which are consistent with industry practice and sealed by a licensed professional engineer, and
- ……visual observation on May 27, 2009, where no warning signs of concern were noted.

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8.0 MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATIONAL PROCEDURES – Provided by Dynegy (Appendix A, Document 7); written to comply with Illinois Dam Safety criteria.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES - Provided by Dynegy (Appendix A, Document 7); written to comply with Illinois Dam Safety criteria. Reviewed and is consistent with industry practice.

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATION

8.3.1 Adequacy of Operational Procedures – The operations procedures were written to comply with Illinois Dam Safety criteria and represent an adequate means of gathering necessary data to monitor the CCW disposal system.

8.3.2 Adequacy of Maintenance – The maintenance plan was written to comply with Illinois Dam Safety criteria and is consistent with maintenance plans for embankments of similar size and hazard classification.

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9.0 SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES – See Operations and Maintenance Plan (Appendix A, Document 7)

9.2 INSTRUMENTATION MONITORING

9.2.1 Instrumentation Plan – None; it is not common for embankment dams to have an instrumentation plan. If concerns arise in the future concerning embankment stability, a piezometer plan could be developed,

9.2.2 Instrumentation Monitoring Results – None as there is no instrumentation to monitor.

9.2.3 Evaluation – Not applicable

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program – Appears to be adequate

9.3.2 Adequacy of Instrumentation Monitoring Program - Not applicable

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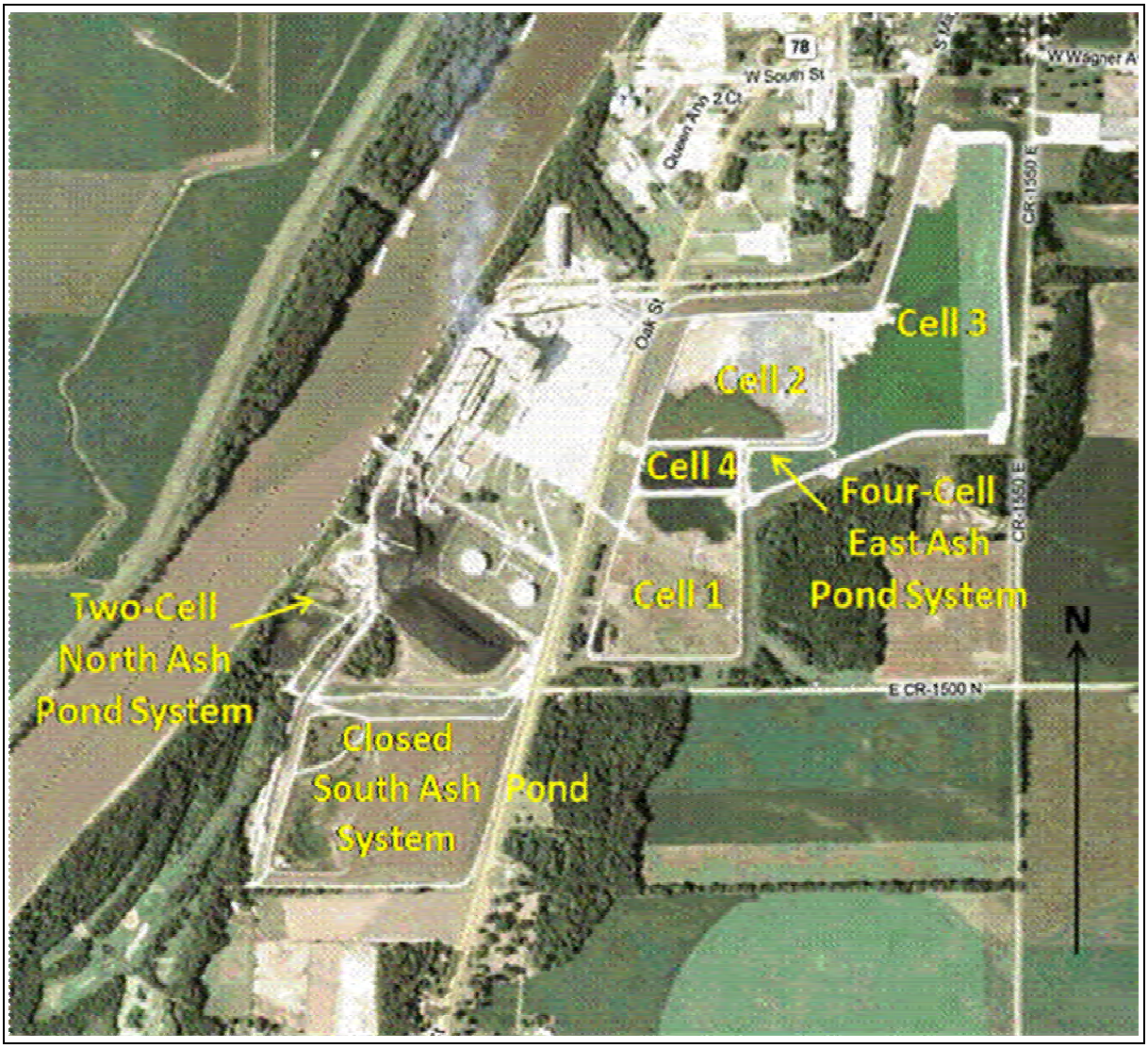

Figure 1: Havana Power Plant Aerial Map

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Figure 2: Havana Power Plant Vicinity Map

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